

Fraxinus excelsior in Europe: distribution, habitat, usage and threats

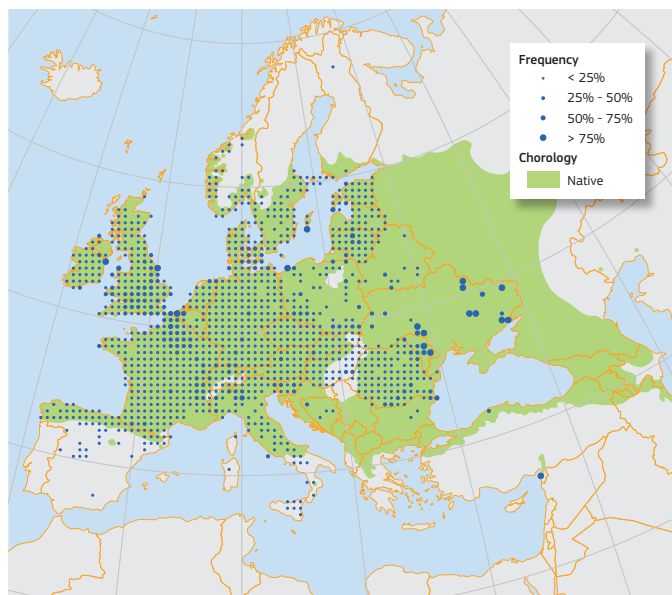
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Common ash (*Fraxinus excelsior* L.) is a medium-sized deciduous tree with large compound leaves that develop relatively late in spring. It flowers before leaf-buds burst and trees can carry male, female, or hermaphrodite flowers, or different combinations of the flower types. It grows throughout the European temperate zone, but is absent from the driest Mediterranean areas because it does not tolerate extended summer drought, and from the northern boreal regions, with its seedlings in particular being vulnerable to late spring frost. Soils exert a strong control on common ash distribution locally. The species grows best on fertile soils where soil pH exceeds 5.5. It rarely forms pure stands, more often it is found in small groups in mixed stands. Ash trees produce high quality timber that combines light weight, strength, and flexibility. Before the mass use of steel, it was used for a wide range of purposes, from agricultural implements to construction of boat and car frames. Today it is still popular for tool handles, flooring, and veneers, owing to its consistent grain and structural properties.

Common ash (*Fraxinus excelsior* L.) is a medium-sized deciduous tree, usually growing to 20–35 m and only occasionally reaching 45 m¹. The crown is domed and open with ascending branches. The trees develop a smooth, pale grey bark that thickens and develops fissures with age. Its leaves are compound, with 9–13 leaflets, odd **pinnate**, **serrated**, and stalkless. The individual leaflets measure 3–12 cm by 0.8–3 cm, composing leaves of 20–35 cm. The flowers open before the leaves unfold, which occurs relatively late in spring compared with other trees. The flowers develop in bunches of 100 to 400, without petals, exposing the pale green styles and filaments and the dark purple stigmas and anthers. Distribution of sexuality is complex. This ash species is termed as polygamous, because plants can develop only male or female flowers, or **unisexual** inflorescences with only male and female flowers carried separately, or even **hermaphrodite** flowers. Recent studies indicate that it might be functionally **dioecious**. Common ash is wind pollinated. The seeds ripen individually in oval-shaped **samaras**, flattened, 2–5 cm long, that by the end of summer hang in bunches from the branches. Seeds usually lie dormant for two years, but sometimes up to six, before germinating. Once they are 20 to 30 years old, trees produce fruits annually, with more abundant production every 2 to 5 years^{2–8}.

Distribution

Common ash is naturally found throughout the European temperate zone, from the Atlantic coast to the Volga River. It has a wider distribution than the two other native ash species, narrow-leaved ash (*Fraxinus angustifolia*) and manna ash (*Fraxinus ornus*), coinciding with that of pedunculate oak (*Quercus robur*), the characteristic species of the temperate deciduous forests. It



Map 1: Plot distribution and simplified chorology map for *Fraxinus excelsior*. Frequency of *Fraxinus excelsior* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *F. excelsior* is derived after EUFORGEN¹⁰.

is absent from the centre and South of the Iberian Peninsula, south of Italian and Balkan peninsulas, northern **Fennoscandia** and Iceland^{5, 6, 9–11}. Its regional distribution limits appear to be set by the energy requirements to complete its annual life cycle in the north, minimum temperatures in the east, and moisture availability in the South and South-East⁵. In the eastern part of its distribution (Romania, Turkey, Caucasus, and northern Iran) a variety is distinguished by **pubescent** shoots and leaves and



Common ash tree with a straight trunk. This species can reach 45 m in height. (Copyright Stefano Zeraushek, www.flickr.com: AP)

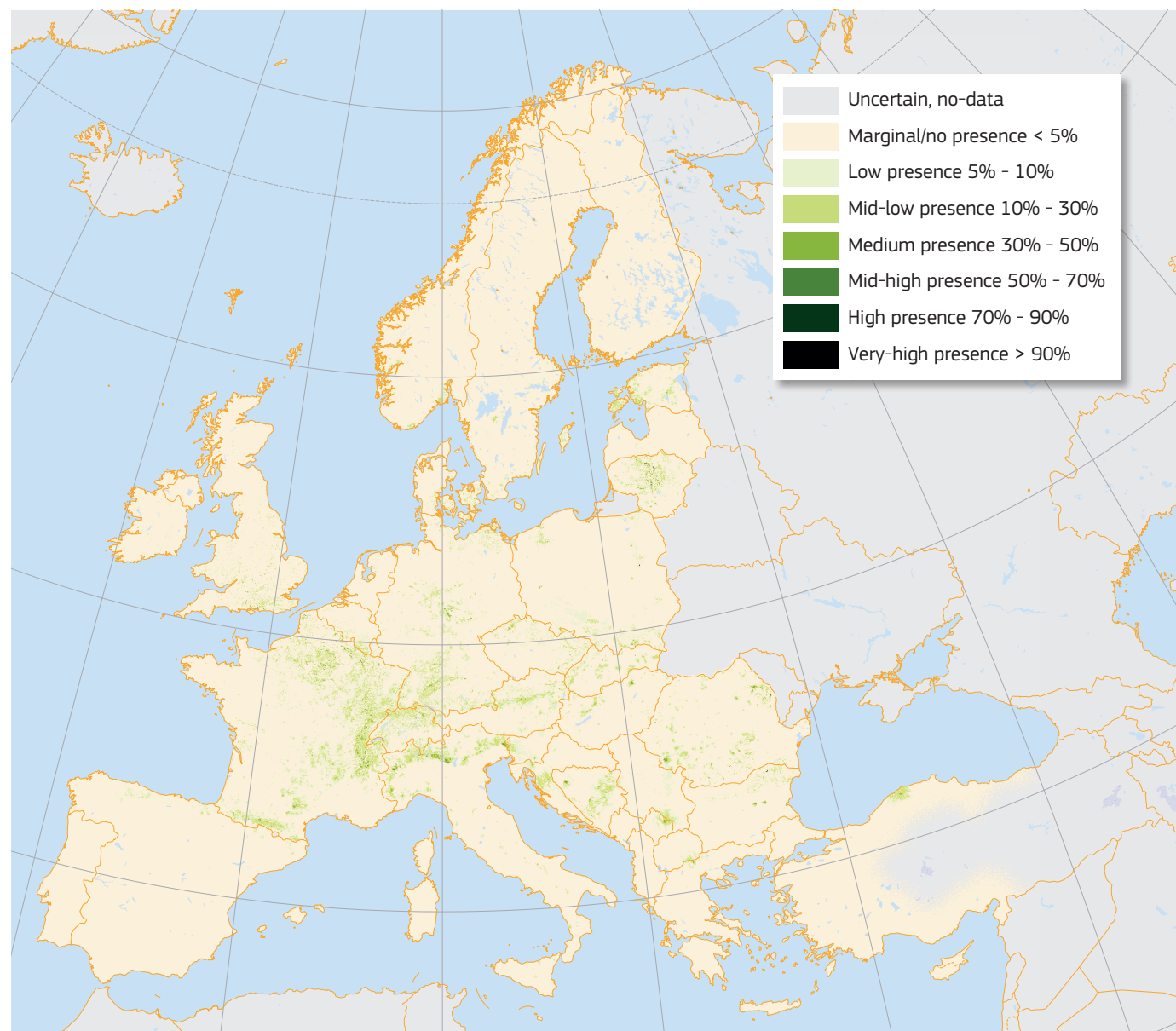
some authors treat it as subspecies (*Fraxinus excelsior* ssp. *coriariifolia*) or as a separate species⁷. In the southern part of its distribution it occurs with narrow-leaved ash (*Fraxinus angustifolia*), which has a more Mediterranean distribution. They can naturally hybridise resulting in individuals with intermediate traits, and it can be difficult to distinguish between them^{12, 13}.

Habitat and Ecology

In the northern and western parts of its range, common ash grows in lowland forests, while further South and West it increasingly grows in mountainous areas. In the Pyrenees and in the Alps, it grows up to 1600–1800 m. However, at the southern edge of the species distribution, in Iran, it can be found up to 2200 m^{6, 14}. This ash grows best on rich soils with high clay or silt fractions, adequate nitrogen, calcium, magnesium, and phosphorus content, and where soil pH exceeds 5.5. It does not thrive on acidic soils, presumably because of their high aluminium concentration. The species is **mesophile** and highly tolerant of seasonal water-logging, but not of prolonged flooding, and thus is often found in flood-plain forests with clay-loam soils, unless the soils are highly compacted. The species tolerates a relatively broad range of nutrient and water conditions, as it



Juvenile composite leaves with 9–13 leaflets; when mature they can reach over 30 cm long. (Copyright Roberto Verzo, www.flickr.com: CC-BY)



Map 2: High resolution distribution map estimating the **relative probability of presence**.

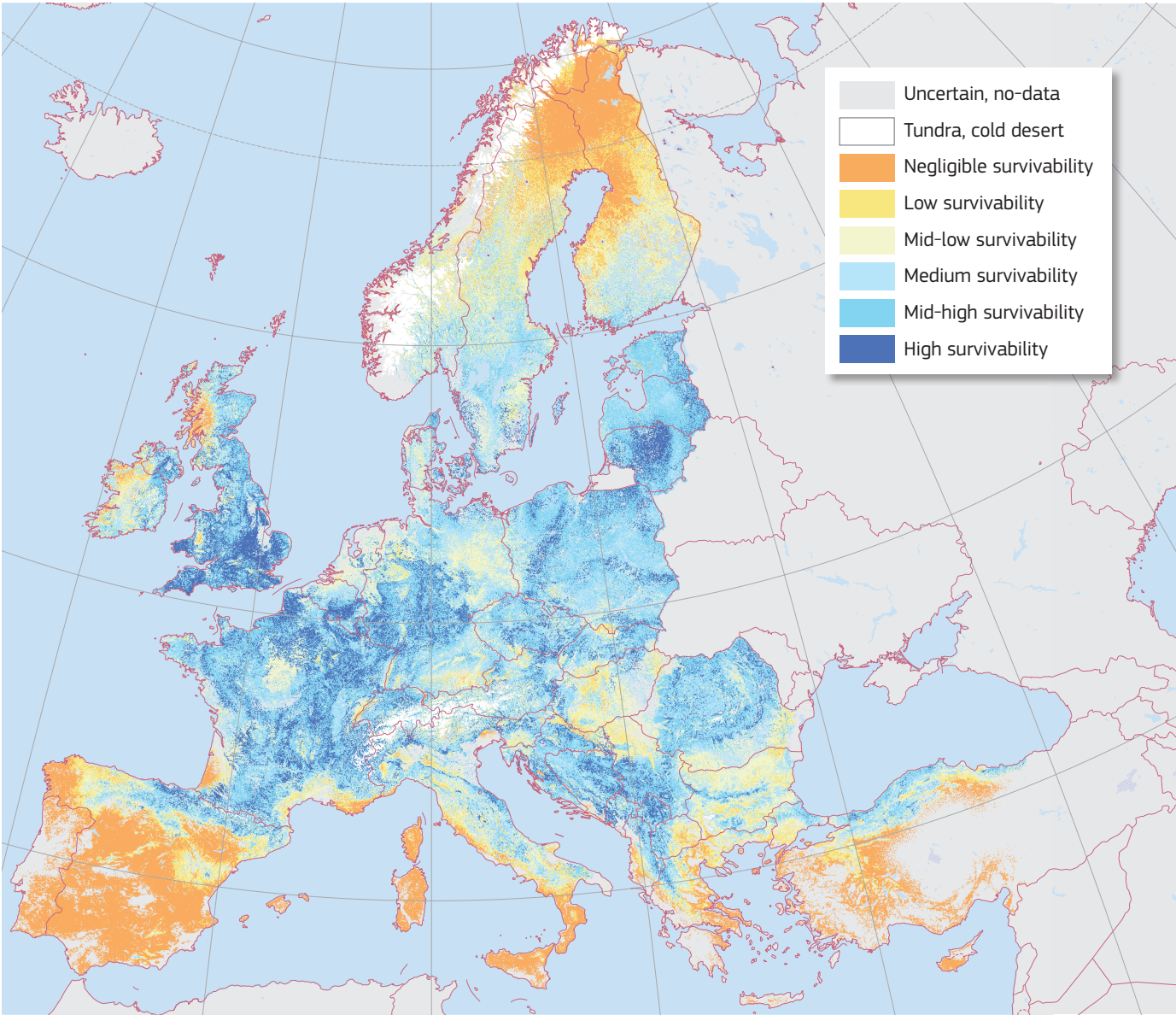
can also grow in ravines and often water-deficient stony slopes, where it might benefit from reduced competition and particular forestry practices^{5, 6, 15}. It is a strong light-demander in its mature stages, but its seedlings can be shade-tolerant for the first years. Young trees show a very rapid growth, although full overhead light is necessary for developing vigorous plants^{4, 16}. This tree has efficient dispersal and natural regeneration mechanisms, but it is only a strong competitor under certain habitat conditions. For example, in continental Europe, it can regenerate and grow vigorously when beech (*Fagus sylvatica*) seedlings and saplings are absent or unproductive. Combining characteristics of pioneer species and permanent forest components, the species is able to play a role in both primary and secondary succession. Often, it occurs as an intermediate in ecological succession or takes advantage of disturbance in extant forest stands¹⁴. In mature forests, common ash trees are often found in groups within mixed stands, where it can be highly competitive and sometimes it forms near to pure stands. Otherwise it occurs as secondary species in mixed broad-leaved forests dominated by beech (*Fagus sylvatica*), pedunculate and sessile oaks (*Quercus robur* and *Q. petraea*), downy birch (*Betula pubescens*), sycamore maple (*Acer pseudoplatanus*), European alder (*Alnus glutinosa*), or grey alder (*Alnus incana*)^{5, 16, 17}.



Dark purple anthers of ash flowers, which are without petals. (Copyright David Nicholls, www.naturespot.ork.uk: AP)

Importance and Usage

The elasticity, hardness, and pressure, shock and splintering resistance of common ash wood make it economically highly valuable, and commercially more important than that of the two other native ash species in Europe (*Fraxinus angustifolia* and *Fraxinus ornus*). The wood is much-used for tool handles and sports equipment, and also in earlier times, before the widespread use of steel, for weapon handles, agricultural implements, carriages and car and boat frames. Furthermore, its straight grain and consistency, with **sapwood** and **hardwood** differing little, make it very valuable for veneers, furniture, and flooring. Stem forking is undesirable and can be caused by frost injury, water stress, or animal browsing. Older trees can also develop so-called 'black heart', a non-fungal staining of the wood, which reduces the wood value^{5, 16}. Traditionally the leaves have been used as animal fodder during winter, while the bark was used to tan calf



Map 3: High resolution map estimating the maximum habitat suitability.

skin. In central Europe it has been widely used as an ornamental tree along roads and city streets. In many countries it has some ethnic, cultural, and mythological significance⁶.

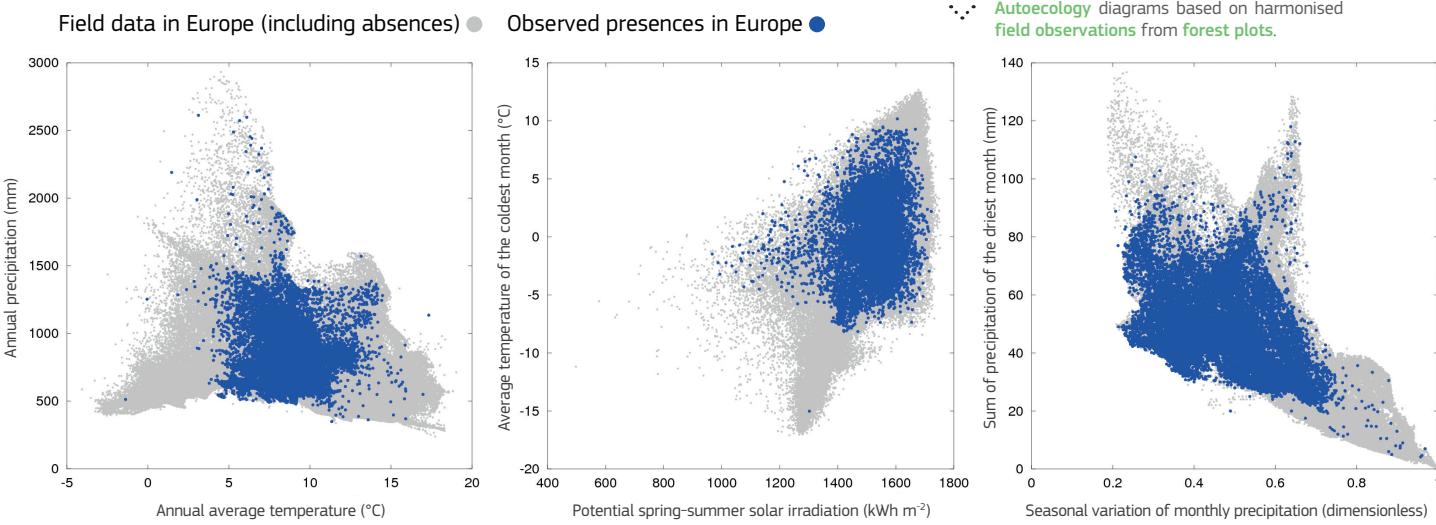
Threats and Diseases

Since it was observed on a large scale in Poland in 1992, the ash dieback phenomenon has spread to other countries in eastern, northern, and central Europe. In many European countries it has since caused the death of over 90% of all ash trees^{18, 19}. The fungus *Hymenoscyphus fraxineus*, also known as *Chalara fraxinea*, a name designating its asexual stage, is primarily responsible for this invasive disease, causing crown dieback, and this fungus is potentially subject to expansion in the European temperate oceanic ecological zones^{20, 21}. It is visible as a reddish discolouration of the bark in the lower portion of the stem, and eventually often kills the tree. In young trees, death can occur in the same growing season in which the symptoms first become visually noticeable. Even if older trees might resist longer, they will be greatly weakened and susceptible to other lethal diseases or pests²². The emerald ash borer (*Agrilus planipennis*) is a beetle native to Asia and eastern Russia. While its adults graze on ash leaves, the emerald ash borer larvae feed on the phloem, which can kill the tree. It was observed in western Russia and Sweden in 2007, which has caused concern that the species will spread to other European countries and cause damage to ash trees. In North America, the emerald ash borer was first discovered in 2002, after probably entering from Asia in shipping material. Since then it has

rapidly spread across several US states, primarily through natural dispersal and the transport of firewood and other wood products containing ash bark. In infected areas, the pest has caused very high mortality of the North American ash species, particularly green ash (*Fraxinus pennsylvanica*), black ash (*Fraxinus nigra*), and white ash (*Fraxinus americana*)^{5, 23, 24}. The bacterium *Pseudomonas syringae* subsp. *savastanoi* pv. *fraxini* and the fungus *Nectria galligena* can cause cankers on common ash trees, which adversely affect their economic value in managed stands. The most severe infections occur in extreme habitats^{8, 16, 20}.

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